1.2: Pseudoscience

A *pseudoscience* is a belief or process which masquerades as science in an attempt to claim a legitimacy which it would not otherwise be able to achieve on its own terms; it is often known as *fringe*-or *alternative* science. The most important of its defects is usually the lack of the carefully controlled and thoughtfully interpreted experiments which provide the foundation of the natural sciences and which contribute to their advancement.

Of course, the pursuit of scientific knowledge usually involves elements of intuition and guesswork; experiments do not always test a theory adequately, and experimental results can be incorrectly interpreted or even wrong. In legitimate science, however, these problems tend to be self-correcting, if not by the original researchers themselves, then through the critical scrutiny of the greater scientific community. Critical thinking is an essential element of science.

Other Types of Defective Science

There have been several well-documented instances in which the correction process referred to above was delayed until after the initial incorrect interpretation became widely publicized, resulting in what has been called ***pathological science***. The best known of these incidents are the "discoveries" of N-rays, of polywaters, and of cold fusion. All of these could have been averted if the researchers had not been so enthused with their results that they publicized them before they had received proper review by others. Human nature being what it is, there is always some danger of this happening; to discourage it, most of the prestigious scientific journals will refuse to accept reports of noteworthy work that has already been made public.

Another term, *junk science*, is often used to describe scientific theories or data which, while perhaps legitimate in themselves, are believed to be mistakenly used to support an opposing position. There is usually an element of political or ideological bias in the use of the term. Thus the arguments in favor of limiting the use of fossil fuels in order to reduce global warming are often characterized as junk science by those who do not wish to see such restrictions imposed, and who claim that other factors may well be the cause of global warming. A wide variety of **commercial advertising** (ranging from hype to outright fraud) would also fall into this category; at its most egregious it might better be described as *deceptive science*.

This description of **Ivory Soap** is a classic example of junk science from the 19th century. Not only is the term "pure" meaningless when applied to an undefined mixture such as bath soap, but the implication that its ability to float is evidence of this purity is deceptive. The low density is achieved by beating air bubbles into it, actually reducing the "purity" of the product and in a sense cheating the consumer.

Hoax science is another category that describes deliberately contrived sensationalist writings that have received wide publicity (and earned substantial royalties for their authors.) Immanual Velikovsky's *Worlds in Collision* (1950) is now probably the best known of these, followed by Erich von Däniken's *Chariots of the Gods?* (1968). Perhaps the most recent contender in this field is David Talbott, who with Wallace Thornhill wrote *The Electric Universe* and *Thunderbolts of the Gods*.

Fraudulent science and *Scientific Misconduct* refer to work that is intentionally fabricated or misrepresented for personal (recognition or career-advancement) or commercial (marketing or regulatory) reasons. Suppression of science for political reasons often occurred during the second Bush administration. The tobacco and pharmaceutical industries have been notoriously implicated in the latter category. The tobacco industry even published a phoney "scientific" journal containing articles written by hack authors that disputed warnings about smoking-induced cancer.

Charges of minor fudging go back to the days of Ptolemy, Gailileo, and Isaac Newton, but revelations of more contemporary frauds and their contamination of the scientific literature makes these far more problematic. Since about 1980, scientists at several major U.S. universities have been compelled to withdraw articles from prestigious journals. One of the most widely-publicized cases was that of the eminent Korean researcher who reported bogus stem cell results. Some rather troubling recent cases involve at least seventy articles describing bogus chemical structures reported by a group of scientists in China, and about an equal number of papers that had been forged or falsified by one or more scientists at a university in India.

Finally, there is just plain *bad science*, which would logically encompass all of the evils being discussed here, but is commonly used to describe well-intentioned but incorrect, obsolete, incomplete, or over-simplified expositions of scientific ideas. An example would be the statement that electrons revolve in orbits around the atomic nucleus, a picture that was discredited in the 1920's, but is so much more vivid and easily grasped than the one that supplanted it that it shows no sign of dying out.

In ordinary conversation, the word "theory" connotes an opinion, a conjecture, or a supposition. But in science, the term has a much more limited meaning. A scientific theory is an attempt to explain some aspect of the natural world in terms of empirical evidence and observation. It commonly draws upon established principles and knowledge with the aim of extending them in a logical and consistent way that enables one to make useful predictions. All scientific theories are tentative and subject to being tested and modified. As theories become more mature, they grow into more organized bodies of knowledge that enable us to understand and predict a wider range of phenomena. Examples of such theories are quantum theory, Einstein's theories of relativity, and evolution.

Scientific theories fall into two categories:

1. Theories that have been shown to be incorrect, usually because they are not consistent with new observations;
2. All other theories

Hence, theories cannot be proven to be correct; there is always the possibility that further observations will disprove the theory. Furthremore, a theory that cannot be refuted or falsified is not a scientific theory.

For example, the theories that underlie astrology (the doctrine that the positions of the stars can influence one's life) are not falsifiable because they, and the predictions that follow from them, are so vaguely stated that the failure of these predictions can always be "explained away" by assuming that various other influences were not taken into account. It is similarly impossible to falsify so-called "creation science" or "intelligent design" because one can simply evoke the "then a miracle occurs" at any desired stage.

Recognizing Pseudoscience?

There is no single test that unambiguously distinguishes between science and pseudoscience, but as the two diverge more and more from one another, certain differences become apparent, and these tend to be remarkably consistent across all fields of interest. In examining the following table, it might be helpful to consider examples of astronomy *vs.* astrology, or of chemistry vs. alchemy, which at one time were single fields that gradually diverged into sciences and pseudosciences.

Many scientists' ordinary response to pseudoscientific claims is simply to laugh at them. But mythology has always been an important part of human culture, often by giving people the illusion of having some direct control over their lives. This can lead to their becoming advocates for various kinds of health quackery, to commercial scams, and to cult-like organizations such as scientology. Worst of all, they can pressure political and educational circles to adopt their ideologies.

Does the "Establishment" Actively Suppress new Ideas?

Anyone who has been around for long enough has encountered statements like these:

- An inventor's design for a device that uses water as a fuel has been bought up and suppressed by the oil companies.
- "Alternative health" techniques (homeopathy, chiropractic, chelation therapy— you name it!) are actively suppressed by the medical profession or the pharmaceutical industry in a desperate attempt to serve their selfish interests.
- Reports of unidentified flying objects (UFO's) are suppressed by the U.S. Government in an attempt to prevent panic and/or to maintain control over citizens.
- Editors of scientific journals and the reviewers they call on to assess the worth of submitted papers reject out-of-hand anything that comes from persons who are not members of the scientific "establishment" or which report results not consistent with presently-accepted science.

Claims of these kinds are frequently made and widely believed, especially by those who are inclined to see conspiracies around every corner. There is little if any evidence for any of these claims. The real reason that new devices or new theories get thrown aside is that the arguments or evidence adduced to support them is inadequate or not credible. The individuals who believe themselves to be unfairly thwarted by the scientific community are very often so isolated from it that they are unable to appreciate its norms of clarity, rigor, and consistency with existing science.

A common refrain is that " they laughed at Galileo, at Thompson, and at Wegner," whose theores were eventually supported. Well, with Galileo, they did not exactly laugh; it was more a case of challenge to religious doctrine that forced him to recant his assertion that the Sun, and not the Earth, is at the center of the solar system. There have been innumerable cases in which the world was simply not ready to accept a new idea. This was especially common before the scientific method had been developed, and before the technology needed to apply it had become available.

When J.J. Thomson discovered evidence that the atom is not the ultimate fundamental particle and could be broken up into smaller units, even Thomson himself was reluctant to accept it, and he became a laughingstock for several years until more definitive evidence became available.

Alfred Wegener's theory of continental drift was bitterly attacked when it was first published in 1915, and it did not become generally accepted until about 50 years later. Others had made similar proposals based on the way the continents of Africa and South America could be fitted together, but Wegener was the first to make a careful study of fossil and geological similarities between the two continents. Nevertheless, the idea that continents could float around was too hard to accept at a time when nothing was known about the interior structure of the Earth, and the evidence he presented was rejected as inadequate.

On the other hand, the even-more-revolutionary concepts of special- and general relativity, and of quantum theory (which developed in several stages), achieved rapid acceptance when they were first presented, as did Louis Pasteur's germ theory of disease. In all of these cases the new theories provided credible explanations for what was previously unexplainable, and the tools for confirming them existed at the time, or in the case of general relativity, would soon become available.
